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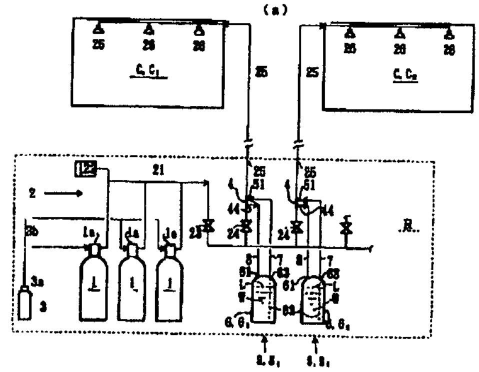
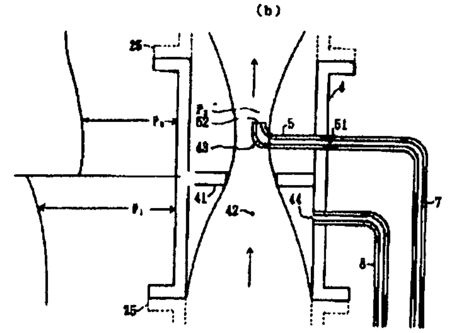
(54)【発明の名称】　水噴霧付き気体消火装置

(57)【要約】
【課題】　気体消火剤と水との二流体消火装置を一体的に簡素に構成する。
【解決手段】　気体消火装置としての窒素消火装置は、通常の構成に加えて、管オリフィス部4、ノズル管5、水容器6、これらの間を結合する水供給管7及び窒素導入管8等を備えている。
【効果】　矢印の方向に窒素が流れると、オリフィス41によって窒素出口44がノズル管5の水出口52より高い圧力になり、水容器6内の水が水出口から放出され、個別消火ラインの根元位置で水と窒素が混ぜられる。そのため、消火ライン25でも水が小粒化され、噴射ヘッド26から噴射されると霧化され、窒素を補助し消火効果を高める。既存の窒素消火装置を変更せず、容易に実施できる。

(a)



(b)



【特許請求の範囲】

【請求項1】　気体消火剤を高圧に充填した消火剤容器から配管系を導設して消火対象区画に気体消火剤を供給可能な気体消火装置において、

前記配管系のうちの前記消火剤容器の近傍部分に設けられ水入口及び前記近傍部分の中に水を出せる水出口を備えた水供給部材と、前記配管系とは別に前記水供給部材の近傍の低い位置に設けられ水が溜められる水容器であって溜められた前記水の上部に開口した加圧用気体入口と前記水の底部に通じる水取出口とを備えた水容器と、前記近傍部分に開けられた加圧用気体出口と、前記水入口と前記水取出口とを結合する水用管と、前記加圧用気体出口と前記加圧用気体入口とを結合する気体用管と、を有し、前記加圧用気体出口と前記水出口とは前記配管系に前記気体消火剤が流れたときに前記加圧用気体出口の部分の圧力が前記水出口の部分の圧力より高くなる関係に設けられることを特徴とする気体消火装置。

【請求項2】　前記近傍部分は前記消火剤が流れたときに相対的に圧力の高い部分と低い部分とを形成するように設けられた差圧発生部材を備え、前記加圧用気体出口は前記圧力の高い部分に設けられ前記水出口は前記圧力の低い部分の近傍に設けられていることを特徴とする請求項1に記載の気体消火装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、気体消火剤を高圧に充填した消火剤容器から配管系を導設して消火対象区画に気体消火剤を供給可能な気体消火装置に関し、特に水と気体消火剤とを併用した二流体消火技術に関する。

【0002】

【従来の技術】窒素や二酸化炭素等の気体消火剤と噴霧水とを併用した消火装置としては、これらをそれぞれ別の配管によって消火すべき部屋まで導設し、消火対象物に対して気体消火剤と微粒子水滴とを互いに接近した位置から別々に噴射し、少ない水量の水噴霧によって気体消火剤の濃度を下げて人体に対する安全性を向上させようとした装置が提案されている（特開平８－３３７３０号公報参照）。

【０００３】しかしながら、このような装置では、気体消火剤の配管系と共に高圧の水ポンプや水の配管系が二重に必要となり、装置構成が複雑になってコストが高くなる。又、水用及び気体消火剤用の両方の装置を操作する必要があり、操作が面倒で装置の保守整備にも余分の手間がかかる。更に、ポンプが２０kgf/cm^2 程度の低い圧力であるため、水の霧化が不十分になる。

【０００４】一方、水のみの噴霧消火装置として、水に添加剤を加えて水の表面張力を下げて低圧でも霧化し易くすると共に、添加剤によって水の沸点を高くして浮遊時間を長くし、消火と燃焼抑制効果とを高めようとした装置が提案されている（特開平８－３３７３１号公報参照）。しかしながら、このような装置における噴霧水だけでは消火剤としての十分な量を得るのが難しく、気化消火剤としての効果が不十分である。又添加剤の量の調整も難しく、更に添加剤によって消火される部屋が汚染されクリーンな消火ができないという問題がある。

【０００５】

【発明が解決しようとする課題】本発明は従来技術に於ける上記問題を解決し、構造が簡単で低コストで操作を必要とせずクリーンな水噴霧装置を付加し、消火効果及び安全性の高い気体消火装置を提供することを課題とする。

【０００６】

【課題を解決するための手段】本発明は上記課題を解決するために、請求項１の発明は、気体消火剤を高圧に充填した消火剤容器から配管系を導設して消火対象区画に気体消火剤を供給可能な気体消火装置において、前記配管系のうちの前記消火剤容器の近傍部分に設けられ水入口及び前記近傍部分の中に水を出せる水出口を備えた水供給部材と、前記配管系とは別に前記水供給部材の近傍の低い位置に設けられ水が溜められる水容器であって溜められた前記水の上部に開口した加圧用気体入口と前記水の底部に通じる水取出口とを備えた水容器と、前記近傍部分に開けられた加圧用気体出口と、前記水入口と前記水取出口とを結合する水用管と、前記加圧用気体出口と前記加圧用気体入口とを結合する気体用管と、を有し、前記加圧用気体出口と前記水出口とは前記配管系に前記気体消火剤が流れたときに前記加圧用気体出口の部分の圧力が前記水出口の部分の圧力より高くなる関係に設けられることを特徴とする。

【０００７】請求項２の発明は、上記に加えて、前記近傍部分は前記消火剤が流れたときに相対的に圧力の高い部分と低い部分とを形成するように設けられた差圧発生部材を備え、前記加圧用気体出口は前記圧力の高い部分に設けられ前記水出口は前記圧力の低い部分の近傍に設けられていることを特徴とする。

【０００８】

【発明の実施の形態】図１は本発明を適用した気体消火装置としての窒素消火装置の全体構成及びその噴霧水注入部分の構成の一例を示す。

【０００９】窒素消火装置は、気体消火剤としての窒素を１５０kgf/cm^2 程度の高圧に充填した消火剤容器としての窒素容器１から配管系２を導設して消火対象区画であるビルや工場等の一定の消火区画Ｃ（以下では単に「区画Ｃ」ということがある）に窒素を供給可能な装置であり、噴霧用水注入部分Ｓを備えている。

【００１０】このような窒素消火装置は、通常の構成として、容器付き弁１ａ、１１０kgf/cm^{2}G程度の圧力を持つ起動用のCO_2 ボンベ３、これに装着され通常ソレノイド等で作動するスターター３ａ、起動ガスライン３ｂ、配管系２のうちの消火元ライン２１、安全装置２

2、元弁２３、消火区画Ｃに対応して設けられる選択弁２４、個別消火ライン２５、区画Ｃ内に必要数配設された噴射ヘッド２６、その他図示していないがスターター３ａに接続される制御盤、これに接続される手動及び必要に応じて設けられる自動起動装置、等によって構成されている。

【００１１】このような窒素消火装置のうち、窒素容器１から選択弁２４を経由して個別消火ライン２５の途中までの部分は、図において点線で示す如く通常建物の地下室等に設けられる容器室Ｒの中に配置される。そして、各区画Ｃには選択弁２４以後長く導設される個別消火ライン２５を経由して窒素が供給される。なお、本例では窒素容器１を３本だけ図示しているが、実際の設備では数１０本以上設けられることが多い。又、消火区画Ｃも２区画だけ図示しているが、ビルや工場等では多区画であることが多い。

【００１２】噴霧用水注入部分Ｓは、管オリフィス部４、水供給部材としてのノズル管５、水容器６、水用管である水供給管７、気体用管である窒素補給管８等によって構成されている。

【００１３】管オリフィス部４は、管内に差圧発生部材としてのオリフィス４１を備え、窒素が流れたときに相対的に圧力の高い部分である上流部４２と圧力の低い部分である下流部４３とを形成するように設けられている。この管オリフィス部４は、本例では差圧発生部材であると共に、配管系２のうちの窒素容器１の近傍部分であり、配管系２において個別消火ライン２５中の選択弁２４の上部に近い位置に介装されている。又、管オリフィス部４には、その上流部４２の位置に加圧用気体出口である窒素出口４４が開口している。

【００１４】ノズル管５は、水入口５１及び水出口５２を備えている。ノズル管５も消火剤容器１の近傍部分に設けられるが、本例では近傍部分として上記の如く管オリフィス部４が設けられるので、ノズル管５はその中の下流部４３部分に設けられている。そして水出口５２は管オリフィス部４の中に水を出せるように開口している。

【００１５】水容器６は、配管系２とは別にノズル管５の近傍の低い位置として例えばノズル管５から１ｍ程度下の位置に設けられて、中に水が溜められる，水容器６には、図において水位Ｌを点線で示すように溜められた水Ｗの上部に開口した加圧用気体入口としての窒素入口６１と内管６２を介して水の底部に通じる水水取出口６３が設けられる。なお、内管６２を設ける代わりに、水容器６の底又は底に近い側面の底部位置に直接水取出口６３を設けるようにしてもよい。水供給管７はノズル管５の水入口５１とタンク６の水取出口６３とを結合している。窒素補給管８はオリフィス管４の窒素出口４４と水容器６の窒素入口６１とを結合している。

【００１６】このような噴霧用水注入部分Ｓでは、窒素出口４４と水出口５２とは、配管系２に窒素が流れたときに窒素出口４４の部分の圧力が水出口５２の部分の圧力より高くなる関係に設けられるが、本例では前記の如く、窒素出口４４をオリフィス４１における相対的に圧力の高い上流部４２に設け、一方水出口５２は相対的に圧力の低い下流部４３に設け、更に水出口５２を窒素ガスの流れ方向である矢印で示す上方に向けてこの部分に周囲の窒素流れによる負圧効果を持たせ、窒素出口４４と水出口５２との間で十分な差圧を発生させるようにしている。但し後述するように、差圧を発生させる方法としては他の種々の方法を用いることができる。

【００１７】なお、ノズル管５と水供給管７又は水供給管７と内管６２とは一体部材であっても別の部材であってもよい。水容器６への水の補給は、特に図示していないが、可搬式水タンクを用いて容器に設けられる図示しない水補給口から水を注入したり、水道等の既設の水配管から水補給用の配管を導設する等、適当な方法で行われる。

【００１８】このような構造によれば、窒素容器１から選択弁２４の出口の個別消火ライン２５の一部分までが容器室Ｒ内に配置されるので、噴霧用水注入部分Ｓを構成する管オリフィス部４、ノズル管５、水容器６及び管７、８を全て容器室Ｒ内に配置することができる。従って、装置全体がまとまった合理的な配置になると共に、この容器室Ｒ内において窒素に水を混入させることができる。その結果、本数が多く且つ長くなる水配管を窒素配管とは別にそれぞれの区画Ｃまで導設する必要がなくなり、二流体消火の可能な設備を大幅に簡素化し、配管等のスペースの節約とコスト低減を図ることができる。又、噴霧用水注入部分Ｓを追加するだけで、既存の窒素消火設備を変更することなくそのまま利用することができる。従って、本発明は既存の設備に対する適用性も極めて良い。以上のような水噴霧付き窒素消火装置は次のように運転される。

【００１９】それぞれの容器１、３、６にはそれぞれ窒素、CO_2 及び水が予め入れられていて、火災発生時に対応し得る状態になっている。この状態で例えば図の左側の区画C_1 で火災が発生すると、手動又は自動でスターター２ａが作動され、CO_2 ボンベ３から起動ガスライン３ｂを介して図示しない弁作動機構によって容器付き弁１ａに圧力１１０kgf/cm²G程度の作動ガスが導入され、弁１ａが開いて配管系２に窒素が供給される。元弁２３は通常開いていて、区画C_1 に対応した図において左側の選択弁２４が自動的に開き、同じく左側の個別消火ライン２５を介して区画C_1 に窒素が供給される。

【００２０】このときには、このラインに窒素容器１内の圧力１５０kgf/cm²Gの窒素が１１０kgf/cm²Gまで減圧されて供給され、窒素は噴射ヘッド２６から高速で区画C_1内に噴射される。なお、容器付き弁１ａには種々の形式のものがあるが、この弁により又は他の減圧弁を追

加することにより、消火ラインは通常１１０kgf/cm²Gの圧力に維持される。

【００２１】配管系２に窒素が流れると、管オリフィス部４では図１（ｂ）に示す如く窒素の流線が形成され、圧力曲線で示すようにオリフィス４１の上流部４２部分の圧力P_1 が下流部４３部分の圧力P_2 より相対的に高い圧力になり、又、ノズル管５の水出口５２部分がその周辺の下流部４３の圧力P_2 より更に低い低圧部P_2 ′になるため、窒素出口４４から水容器６の窒素入口６１を介して水面Ｌに作用する圧力P_1 と上記圧力P_2 ′との差圧により、水容器６内の水Ｗが押し出されてノズル部５の水出口５２から噴出する。即ち、何ら操作をすることなく水を供給することができる。

【００２２】このときの水の供給量は、上記差圧、水出口５２と水面Ｌとの高低差、管７、８の抵抗等の諸条件によって定まる。但し、個別消火ライン２５内の窒素の流速は例えば６０ｍ／sec 程度で極めて大きいので、容易に必要な差圧を発生させて十分な水量を流し、目的とする水量を確保することができる。なお、図示していないが、水供給管７又は窒素補給管８の何れか又は双方にニードル弁等を設けて、上記水量を調整できるようにしてもよい。

【００２３】水出口５２から放出された水は初速度を有するが、管内を全体的に流れる窒素の流速に較べると十分小さいので、粒状になった水滴Wpには、図２に示す如く、その質量ｍによる下向きの自重ｍｇとこれより大きく窒素の流れによって生ずる上向きの圧力抵抗である抗力Ｄとが作用する。その結果、水滴Wpは、これらの力の差によって窒素の流れ方向に運ばれると共に、不均等な抗力Ｄによって表面が広がって分割され、小粒化される。そして水滴が小さくなると、その自重よりも搬送力が相対的に大きくなり、水滴は小さい力で搬送されるようになる。その結果、水滴の自重、搬送力、表面張力等がバランスし、ノズル部５から噴出した水は最終的にほぼ一定の大きさに小粒化され、ほぼ一定の流速で管内を搬送されることになる。

【００２４】このように小粒化された水滴が窒素と共に区画C_1 の噴射ヘッド２６に到達すると、これらが１１０kgf/cm²Gの高圧から大気圧まで減圧され、急膨張して区画内に噴射される。そしてこのような極めて大きい圧力差により、小粒化された水は空気抵抗にあって更に粉砕されて微粒子になり、霧状になって窒素と共に区画内に充満する。そして、水分を多く含んだ窒素が火災の熱気や煙に覆うと、水分が気化して空間内の相当の容積を占め、窒素と共に内部空気と置換し、区画内を酸欠状態にして消火効果を上げると共に、気化時の潜熱によって周辺を冷却し冷却鎮火効果も発揮する。即ち、窒素を量的及び質的に補助し、窒素容器の本数を減少させると共に消火効果を増大させることができる。

【００２５】この場合、従来技術のように気体消火装置と共に別ラインとして並設した噴霧水注入用装置では、水の圧力が高くても５０kgf/cm²Gまでであるため、霧化が不十分である。これに対して本発明では、前記の如く窒素との根元混合方式であるため、配管の途中を利用して予め水を小粒化できること、窒素の高圧を利用できるので１１０kgf/cm²Gという高い噴射圧力を得られること、従ってこの高圧の下に既に小粒化した水を更に大幅な減圧・噴射効果が得られること、噴射時に窒素という気体のアシストがあること、等によって必要な量の水を容易に微粒子化することができる。

【００２６】又、従来の水噴霧装置のように水にグリセリンやエチレングリコール等の添加剤を混ぜる必要がないので、窒素と水又は水蒸気だけによるクリーンな消火をすることができる。更に、微小水滴や水蒸気は人体に無害であるため、安全性が高い。

【００２７】以上では、配管系２のうちの窒素容器１に近傍部分としてオリフィス４１を備えた管オリフィス部４を設ける例を示したが、図１（ｂ）のようにノズル管５を配置すれば、前述の如く水出口５２部分の圧力P_2 ′が周囲の圧力P_2 より低くなるため、オリフィス４１を省略することも可能である。この場合には、オリフィス４１を設ける場合よりも水量は減少するが、水を放出することは可能である。図３は窒素出口４４とノズル管５の水出口５２との間に差圧を発生させる構造の他の例を示す。

【００２８】（ａ）では、ノズル管５の先端部分の外側にリング状部材５ａを設けている。このようにすれば、水出口部分の負圧効果を高めて上記P_2 ′を小さくし、窒素出口４４との差圧を大きくして水量を多くすることができる。この場合にも、オリフィス４１を省略することが可能である。（ｂ）は、ノズル管５の先端部分を球状にして多数の小孔５ｂを開け、水を分割放出できるようにした例を示す。このようにすれば、水の微粒化作用を向上させることができる。

【００２９】（ｃ）は管オリフィス部４をベンチュリ管９に変更した例を示す。この場合にもオリフィスと同様に必要な差圧を発生させることができる。（ｄ）は、窒素補給管８に窒素を流す窒素出口４４を管の中心位置まで延設して窒素流れの上流側に向けて開口させた差圧発生部材としてのピトー管部分１０を設けた例を示す。このようにすれば、窒素出口４４部分に動圧を利用し、圧力P_1 を更に大きくすることができる。例えば、圧力１１０kgf/cm²Gの窒素が１００ｍ／sec の流速で流れるとすれば、この部分だけでも約５ｍ水柱の圧力を発生させ、その分だけP_1 を大きくして大きな差圧を得ることができる。このようなピトー管構造を管オリフィス部４と併用してもよい。その場合には、一層差圧が大きくなって供給水量を多くすることができる。

【００３０】なお、本発明の装置では水の霧化性能がよいので、噴射ヘッド２６としては通常の窒素用のものを

そのまま使用することが可能である。但し、必要によっては、中央に直進孔と周辺部分に旋回孔とを備え旋回流によって水の霧化効果を増大させるようにしたスパイラルタイプのノズルや、オリフィスを経由した流体の出口部に針状部材を設けてこれに流体が衝突し粉砕されることによって霧化効果を増大さるようにしたピンタイプのノズル等、周知の微粒子化促進型ノズルを噴射ヘッドとして用いるようにしてもよい。

【0031】更に、以上では気体消火装置が窒素消火装置である例を示したが、二酸化炭素や他の不活性ガス又は窒素を含めてこれらとの混合ガスを用いる気体消火装置に対しても本発明を適用することができる。

【0032】

【発明の効果】以上の如く本発明によれば、請求項1の発明においては、水入口及び配管系の中に水を出せる水出口を備えた水供給部材を配管系のうちの消火剤容器の近傍部分に設けるので、配管系の根元部分で気体消火剤の中に水を注入することが可能になる。又、水供給部材の近傍の低い位置に水が溜められる水容器を配設し、この水容器に、内部に溜められた水の上部に加圧用気体入口と水の底部に通じる水取出口と設けるので、水の上部に圧力をかけて底部から水を押し出すことが可能になる。

【0033】又、気体消火剤の配管系を構成する前記近傍部分に加圧用気体出口を開口し、加圧用気体出口と水容器の加圧用気体入口とを気体用管で結合すると共に水供給部材の水入口と水容器の水取出口とを水用管で結合するので、配管系を流れることになる気体消火剤の圧力を作用させ、それぞれの口を介して水容器内の水を水供給部材の水出口から押し出すことが可能になる。

【0034】そして、加圧用気体出口と水出口とが、配管系に気体消火剤が流れたときに加圧用気体出口の部分の圧力が水出口の部分の圧力より高くなる関係に設けられるので、火災発生時に気体消火剤が流されると、加圧用空気出口と水出口との間に差圧が生じ、この差圧で水容器内の水を水出口から押し出し、気体消火剤中に水を放出させることができる。

【0035】このような水の噴出は、配管系に気体消火剤が流れることにより、自動的且つ理論的に確実に行われる。従って、何ら操作をすることなく、即ち誤操作等のおそれがなく確実に水を供給することができる。又、配管系の近傍部分に水供給部材、水容器及びこれらの結合管を設けるので、これらの全てを気体消火剤容器が装備される容器室に配置することができる。その結果、水を供給する装置全体をまとまった合理的な配置にすることができる。

【0036】又、従来の装置では各消火対象区画まで多本数で且つ長い距離を導設されることになる水配管を、請求項1の発明によって省略することができる。その結果、水と気体との二流体消火の可能な設備を大幅に簡素化し、配管等のスペースの節約とコスト低減を図ることができる。又、水供給部分を追加するだけで気体消火装置自体を変更する必要がないと共に、追加部分の簡単な構造であるため、既存の気体消火設備へも適用が容易である。

【0037】更に、水の根元混合により、消火対象区画までの長い配管系を利用し、気体消火剤の高速流の作用のもとに注入された水を小粒化することができる。そして、このように小粒化された水滴を含む気体消火剤が消火対象区画で噴射されたときには、既に水滴が配管系で小粒化されていること、気体消火剤の高圧を利用して十分高い圧力で噴射できること、噴射時に気体消火剤のアシストがあること、等により、極めて効率良く水を微粒化することができる。

【0038】そして、微粒化され霧状になった水を多く含む気体消火剤が放出されて消火対象区画内に充満し、火災による熱気や煙を覆うと、水分が気化して空間内で相当の容積を占め、気体消火剤を補完して区画内を酸欠状態にして消火効果を上げると共に、水の気化時の潜熱によって周辺を冷却し、鎮火効果も発揮する。

【0039】即ち、水は気体消火剤を量的及び質的に補助し、気体消火剤の消費量を減らすと共に消火効果を増大することができる。そしてこのような効果は、気体消火剤が微粒化された水を随伴して同時に同一場所から同方向に放出されることによって一層顕著になる。又、水に添加剤を混ぜる必要がないので、クリーンな消火をすることができる。更に、微小水滴や水蒸気は人体に無害であるため、消火時の安全性が高くなる。

【0040】請求項2の発明によれば、上記に加えて、近傍部分として差圧発生部材を備え、加圧用気体出口を相対的に圧力の高い部分に設け水出口を圧力の低い部分の近傍に設けるので、確実により大きな差圧を発生させ、水供給部材からの水の供給を容易且つ確実にして多量の水を供給することができる。その結果、気体消火剤の量を一層少なくし、消火効果の増大、安全性の向上、消火コストの低減等の効果を一層増大することができる。

【図面の簡単な説明】

【図1】本発明を適用した水噴霧付き気体消火装置の一例を示し、（ａ）は全体系統の説明図で（ｂ）はその水噴射部分の説明図である。

【図2】窒素の高速流れ中の水滴の流れ状態を示す説明図である。

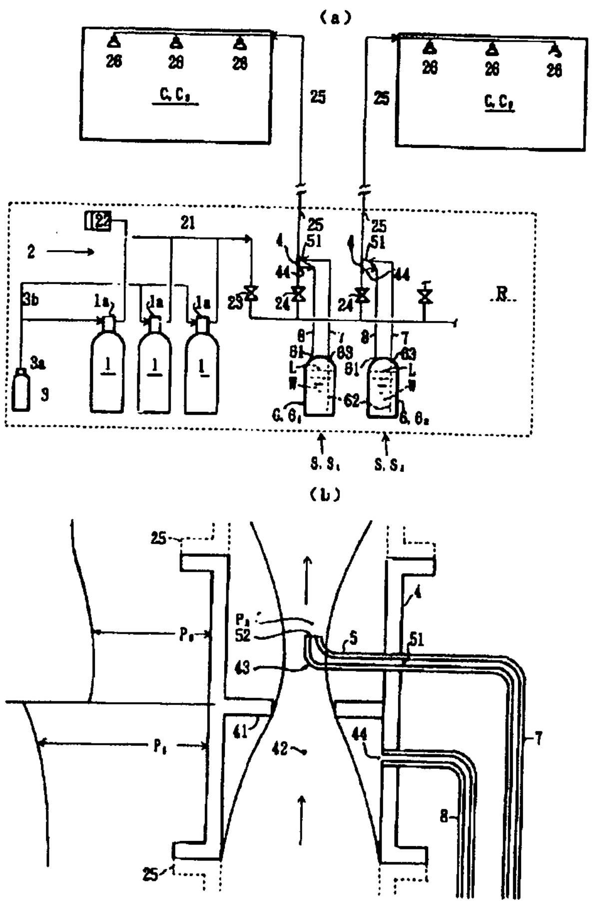
【図3】差圧発生部分の他の構造例の説明図で、（ａ）はノズル管の先端にリング状部材を設けた図、（ｂ）は前記先端を多孔球状部にした図、（ｃ）はベンチュリ管を用いた図、そして（ｄ）は窒素出口にピトー管を用いた図である。

【符号の説明】

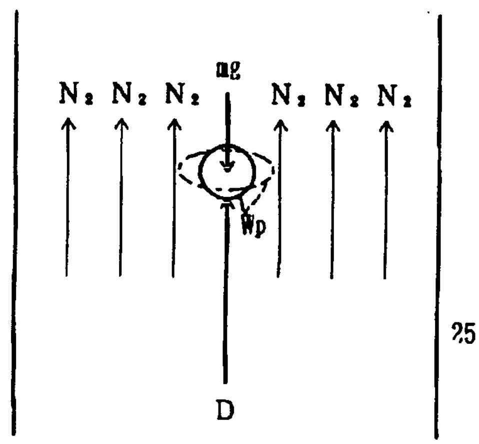
1　窒素容器（消火剤容器）

2　配管系
4　管オリフィス部（差圧発生部材、近傍部分）
5　ノズル管（水供給部材）
6　水容器
7　水供給管（水用管）
8　窒素補給管（気体用管）
9　ベンチュリ管（差圧発生部材、近傍部分）
10　ピトー管部分（差圧発生部材、近傍部分）
41　オリフィス（差圧発生部材）
42　上流部（相対的に圧力の高い部分）
43　下流部（相対的に圧力の低い部分）
44　窒素出口（加圧用気体出口）
51　水入口
52　水供給口
61　窒素入口（加圧用気体入口）
63　水取出口
C　消火区画、区画（消火対象区画）

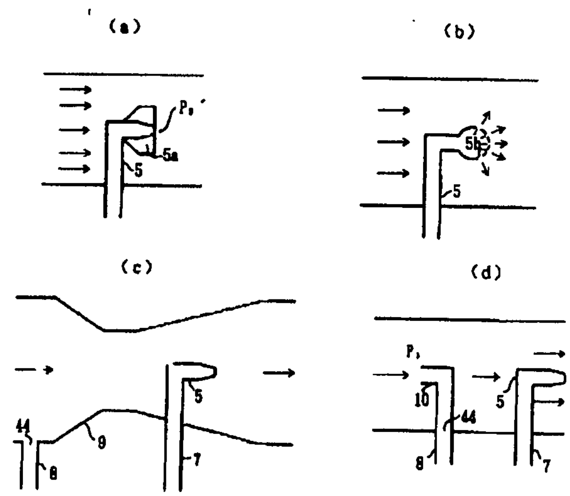
【図1】



【図2】



【図3】



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QB15X QD03 QD11 QD15
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QF15Y

GASEOUS FIRE EXTINGUISHING SYSTEM EQUIPPED WITH WATER SPRAY

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Applicant	Kawasaki Safety Service Industries Co., Ltd.
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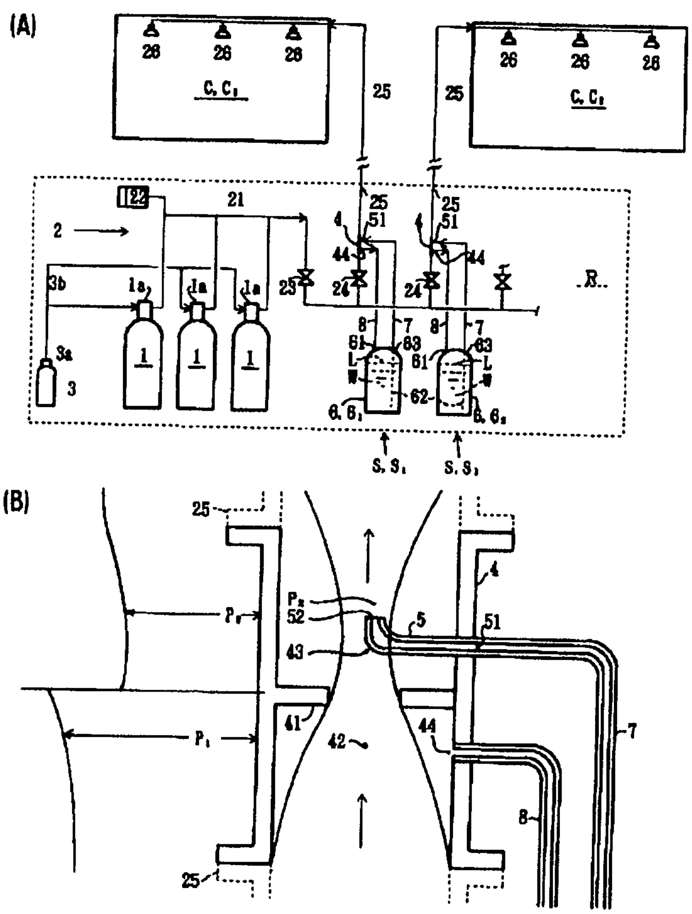
Abstract

TASK: To provide a dual-fluid fire extinguishing system with a simple integrated structure, the two fluids being a gaseous fire extinguishant and water.

SOLUTION: A nitrogen fire extinguishing system serving as the gaseous fire extinguishing system comprises, in addition to conventional components, a variety of components including pipe orifice 4, nozzle pipe 5, water container 6, water supply pipe 7 connecting these, and nitrogen introduction pipe 8.



EFFECTS: When nitrogen flows in the direction indicated by the arrows, orifice 41 results in (i) the pressure at nitrogen outlet 44 becoming higher than at water outlet 52 [1]* of nozzle pipe 5, (ii) water in a water container 6 being discharged from the water outlet, and (iii) water and nitrogen being mixed at the base of an individual fire extinguishing line. Hence water is turned into small droplets [2] in the fire extinguishing lines 25 themselves; is atomized when injected from an injection head 26; assists the nitrogen and enhances the fire extinguishing effect. [*This system*] [3] is readily implemented without changing an existing nitrogen-based fire extinguishing system. [4]

* Numbers in square brackets refer to Translator's Notes appended to the translation.

Claims

1. A gaseous fire extinguishing system provided with a system of pipework [5] from fire extinguishant containers filled with a gaseous fire extinguishant at high pressure, and capable of supplying the gaseous fire extinguishant to a target compartment, said gaseous fire extinguishing system being characterised in that it comprises:

a water supply member [6] provided in the neighbourhood [7] of the aforesaid fire extinguishant containers of the aforesaid pipework system, and having a water inlet [8] and a water outlet [9] for discharging water into the aforesaid neighbourhood;

separate from said pipework system, a water container provided at a low position in the neighbourhood of the aforesaid water supply member, and serving to store water; said water container having a pressurising gas inlet [10] opening above said stored water, and a water discharge port [11] communicating with the bottom of the aforesaid water;

a pressurising gas outlet [12] opening into the aforesaid neighbourhood;

a water pipe [13] joining said water inlet and said water discharge port; and

a gas pipe [14] joining said pressurising gas outlet and said pressurising gas inlet;

wherein said pressurising gas outlet and said water outlet are provided in a relation such that the pressure at said pressurising gas outlet becomes higher than the pressure at said water outlet when the aforesaid gaseous fire extinguishant is flowing in said pipework system.

2. The gaseous fire extinguishing system claimed in Claim 1, wherein:

the aforesaid neighbourhood has a differential pressure generating member [15] that has been provided so as to form a relatively high pressure portion and a relatively low pressure portion when said fire extinguishant is flowing; and

said pressurising gas outlet is provided in said high pressure portion, and said water outlet is provided in the neighbourhood of said low pressure portion.

Detailed Description of the Invention

Technical field of the invention

[0001] The present invention relates to gaseous fire extinguishing systems provided with a system of pipework from fire extinguishant containers filled with high-pressure gaseous fire extinguishant, and capable of supplying the gaseous fire extinguishant to a target compartment. The invention relates in particular to dual-fluid fire extinguishing technology which uses both water and a gaseous fire extinguishant.

Prior art

[0002] A system intended to improve human safety by using a low water content water mist to lower the concentration of gaseous fire extinguishant has been proposed. This system is an example of a fire extinguishing system that makes dual use of sprayed water and a gaseous fire extinguishant such as nitrogen or carbon dioxide (see published Japanese Patent Application, Pub. No. 08-033730). The proposed system employs separate piping to deliver water and gaseous fire extinguishant to a room where a fire is to be extinguished, and sprays the target separately, from mutually close positions, with gaseous fire extinguishant and atomized water droplets.

[0003] However, such a system requires, in addition to pipework for the gaseous fire extinguishant, high-pressure water pumps and duplicate pipework for the water. This results in a complicated system configuration and increased cost. In addition, the necessity of operating both water and gaseous fire extinguishant systems means that operation is troublesome and system maintenance very time-consuming. Moreover, because the pumps deliver low pressures of around 20 kgf/cm^2, there is insufficient atomisation of water.

[0004] A system intended to enhance fire extinguishing and combustion suppression has also been proposed. This system is an example of a water-only spray-type [16] fire extinguishing system (see published Japanese Patent Application, Pub. No. 08-033731). The proposed system combines an additive with water to lower the surface tension of the water in order to make it readily atomize at lower pressures. The additive also raises the boiling point of water, thereby lengthening the time in suspension. However, such a system has a number of problems. Obtaining a sufficient quantity of fire extinguishant on the basis of sprayed water alone is difficult, and sprayed water alone is not sufficiently effective as a gaseous fire extinguishant. It is also difficult to adjust the amount of additive. Furthermore, a room which is subject to fire extinguishing is contaminated with the additive, and so "clean" fire extinguishing is not possible.

Task to which the invention is addressed

[0005] The present invention solves the above-described problems encountered with the prior art, and is addressed to the task of providing a highly effective and very safe gaseous fire extinguishing system which additionally has an automatic [17] "clean" water mist system which is inexpensive and simple in structure.

Means for solving problems

[0006] To solve the above-described problems, the present invention as set forth in Claim 1 is [18] a gaseous fire extinguishing system provided with a system of pipework from fire extinguishant containers filled with a gaseous fire extinguishant at high pressure, and capable of supplying the gaseous fire extinguishant to a target compartment, and is characterised in that it comprises:

- a water supply member provided in the neighbourhood of the fire extinguishant containers of the pipework system, and having a water inlet and a water outlet for discharging water into the aforesaid neighbourhood;
- separate from the aforementioned pipework system, a water container provided at a low position in the neighbourhood of the aforementioned water supply member, and serving to store water; this water container having a pressurising gas inlet opening above the stored water, and a water discharge port communicating with the bottom of the water;
- a pressurising gas outlet opening into the aforementioned neighbourhood;
- a water pipe joining the water inlet and the water discharge port; and
- a gas pipe joining the pressurising gas outlet and the pressurising gas inlet;
- wherein the pressurising gas outlet and the water outlet are provided in a relation such that the pressure at the pressurising gas outlet becomes higher than the pressure at the water outlet when the aforementioned gaseous fire extinguishant is flowing in the pipework system.

[0007] The invention as set forth in Claim 2 has the features described above, and is additionally characterised in that:

- the aforementioned neighbourhood has a differential pressure generating member that has been provided so as to form a relatively high pressure portion and a relatively low pressure portion when the aforementioned fire extinguishant is flowing; and
- the pressurising gas outlet is provided in the high pressure portion, and the water outlet is provided in the neighbourhood of the low pressure portion. [19]

Modes of practising the invention

[0008] FIG. 1 depicts an example of the overall configuration of a nitrogen fire extinguishing system (as the gaseous fire extinguishing system) to which the present invention has been applied, and also gives an example of the configuration of its spray water injection portion. [20]

[0009] The nitrogen fire extinguishing system has pipework system 2 running from nitrogen containers 1 (as the fire extinguishant containers) filled with nitrogen (as the gaseous fire extinguishant) at a high pressure of around 150 kgf/cm^2, and is capable of supplying the nitrogen to a particular fire extinguishing compartment C (this being the target compartment) in for example an office building or a factory (hereinafter, such a fire extinguishing compartment will sometimes be called simply "compartment C").

[0010] As its conventional configuration, this nitrogen fire extinguishing system comprises, *inter alia*: valves 1a fitted to the containers; CO_2 cylinder 3 for startup, this cylinder having a pressure of around 110 kgf/cm^{2}G; starter 3a fitted to this CO_2 cylinder and actuated by means of a conventional solenoid or the like; startup gas lines 3b; fire extinguishing main line 21 of pipework system 2; safety device 22; stop valve 23; selector valves 24 provided in correspondence with fire extinguishing compartments C; individual fire extinguishing lines 25; and the required number of injection heads 26 disposed in each compartment C. Although not illustrated, the conventional configuration also comprises a control panel connected to starter 3a, and a manual starting device connected to this (plus an automatic starting device if required).

[0011] In such a nitrogen fire extinguishing system, the portion including nitrogen containers 1, selector valves 24 and part of individual fire extinguishing lines 25 is arranged inside container room R which is usually provided in for example the basement of a building. This is indicated by a broken line in FIG. 1. Nitrogen is supplied to each compartment C by way of a selector valve 24 and thereafter via an individual fire extinguishing line 25 extending for a considerable distance. Although only three nitrogen containers 1 are depicted in the present example, in a real facility there are often at least several dozen. Again, although two fire extinguishing compartments C are depicted, an office building, factory or the like will frequently have many such compartments.

[0012] A spray water injection portion S [21] comprises, *inter alia,* pipe orifice 4, nozzle pipe 5 (as the water supply member [22]), water container 6, water supply pipe 7 (which is the water pipe [23]), and nitrogen subsidiary supply pipe 8 (which is the gas pipe [24]).

[0013] Pipe orifice 4 comprises orifice 41 in a pipe, with orifice 41 serving as the differential pressure generating member. Pipe orifice 4 is provided in such manner that it forms upstream portion 42 (which is the relatively high pressure portion) and downstream portion 43 (which is the relatively low pressure portion) when nitrogen is flowing. In the present example, this pipe orifice 4 is the differential pressure generating member and is

also in the neighbourhood of nitrogen containers 1 of pipework system 2. Pipe orifice 4 is interposed in pipework system 2 at a position close to and above selector valve 24 in an individual fire extinguishing line 25. Nitrogen outlet 44 (which is the pressurising gas outlet) opens into pipe orifice 4 at a position corresponding to upstream portion 42.

[0014] Nozzle pipe 5 has water inlet 51 and water outlet 52. Nozzle pipe 5 is also provided in the neighbourhood of fire extinguishant containers 1, and in the present example pipe orifice 4 is provided in the neighbourhood of nitrogen containers 1 and nozzle pipe 5 is provided in downstream portion 43 within this neighbourhood. Water outlet 52 opens so as to allow water to be discharged into pipe orifice 4.

[0015] A water container 6 is provided separately from pipework system 2 at a low position in the neighbourhood of nozzle pipe 5 – for example, at a position about 1 metre below nozzle pipe 5 – and water is stored therein. Water container 6 is provided with nitrogen inlet 61 and water discharge port 63. Nitrogen inlet 61 serves as the pressurising gas inlet and opens above stored water W as shown in FIG. 1(A), where water level L is indicated by a dotted line. Water discharge port 63 communicates, via inner pipe 62, with the bottom of the water. Instead of providing inner pipe 62, it would also be acceptable to provide water discharge port 63 directly at a position either at or near the bottom of a side of water container 6. Water supply pipe 7 connects water inlet 51 of nozzle pipe 5 and water discharge port 63 of tank 6. Nitrogen subsidiary supply pipe 8 connects nitrogen outlet 44 of orifice pipe 4 [25] and nitrogen inlet 61 of water container 6.

[0016] In such a spray water injection portion S, nitrogen outlet 44 and water outlet 52 are provided in a relation such that the pressure at nitrogen outlet 44 becomes higher than the pressure at water outlet 52 when nitrogen is flowing in pipework system 2. In the present example, as mentioned above, nitrogen outlet 44 is provided in relatively high-pressure upstream portion 42 of orifice 41, while water outlet 52 is provided in relatively low-pressure downstream portion 43 and is also turned to face upwards, which, as indicated by the arrows, is the direction of the flow of nitrogen gas. As a result, a negative pressure effect is created in this region by the ambient nitrogen flow, and a considerable differential pressure is generated between nitrogen outlet 44 and water outlet 52. However, as will be described hereinafter, various other methods can be used to generate the differential pressure.

[0017] Nozzle pipe 5 and water supply pipe 7, or water supply pipe 7 and inner pipe 62, can be an integral unit or can be separate members. Although not specifically illustrated,

water container 6 is replenished with water by a suitable method such as using a portable tank and introducing water from a water replenishment port (not illustrated) provided in the container, or running piping for water replenishment from existing water piping.

[0018] With such a structure, the system from nitrogen containers 1 to a portion of individual fire extinguishing lines 25 on the outlet side of selector valves 24 is disposed inside container room R, and therefore pipe orifice 4, nozzle pipe 5, water container 6 and pipes 7 and 8 – which constitute spray water injection portion S – can all be disposed within container room R. Consequently, the overall system is arranged in a compact and rational way, and water can be mixed with nitrogen within container room R. As a result, it is no longer necessary to lead, to each compartment C, long water pipes separately from the nitrogen pipes, whereby a facility capable of dual-fluid fire extinguishing can be greatly simplified, the space required for piping can be decreased and cost reduction achieved. Moreover, by simply adding spray water injection portions S, an existing nitrogen fire extinguishing facility can be utilized as it is without alteration. [26] Hence the present invention also has extremely good applicability to existing facilities. A nitrogen fire extinguishing system equipped with water spray in the manner described above is operated as follows.

[0019] Nitrogen, CO_2 and water are introduced in advance into containers 1, 3 and 6 respectively, so that the system is capable of responding if a fire breaks out. In this ready condition, if a fire breaks out in for example compartment C_l (shown on the left-hand side in the drawing), starter 2a [27] is actuated either manually or automatically; the actuating gas at a pressure of around 110 kgf/cm^{2}G is introduced from CO_2 cylinder 3, by means of a valve actuating mechanism (not illustrated) and via startup gas lines 3b, into valves 1a fitted to the containers; and valves 1a open, whereby nitrogen is supplied to pipework system 2. Stop valve 23 is usually open, and the selector valve 24 corresponding to compartment C_l (shown on the left-hand side in the drawing) automatically opens, whereupon nitrogen is supplied to compartment C_l via the individual fire extinguishing line 25 that is likewise on the left-hand side.

[0020] At this point, nitrogen at a pressure of 150 kgf/cm^{2}G inside nitrogen containers 1 has its pressure dropped to 110 kgf/cm^{2}G and is supplied to this individual fire extinguishing line, with the nitrogen being injected at high speed into compartment C_l from injection heads 26. Although valves 1a fitted to the containers can take a variety of

forms, the fire extinguishing lines are usually kept at a pressure of 110 kgf/cm^2G by means of these valves, or by the addition of other, pressure-reducing valves.

[0021] When nitrogen flows into pipework system 2, the nitrogen streamlines depicted in FIG. 1(B) form in pipe orifice 4, and pressure P_1 in upstream portion 42 of orifice 41 becomes higher than pressure P_2 in downstream portion 43, as shown by the pressure curves. Moreover, because water outlet 52 of nozzle pipe 5 is then at a low pressure P_2' which is even lower than pressure P_2 in surrounding downstream portion 43, water W inside water container 6 is pushed out and ejected from water outlet 52 of nozzle 5 [28] by the pressure difference between above-mentioned pressure P_2' and pressure P_1 which acts on water surface L from nitrogen outlet 44, via nitrogen inlet 61 of water container 6. In other words, no particular operation is required to supply water. [29]

[0022] The quantity of water supplied at this time is determined by a number of conditions including the aforementioned differential pressure, the difference in height between water outlet 52 and water level L, and the resistance of pipes 7 and 8. However, because the flow rate of nitrogen inside an individual fire extinguishing line 25 is extremely high – for example, 60 m/s – it is easy to generate the required differential pressure and to cause a plentiful amount of water to flow, and the target quantity of water can be secured. Although not illustrated, a needle valve or the like may be provided on either of, or on both of, water supply pipe 7 and nitrogen subsidiary supply pipe 8, whereby the above-mentioned quantity of water can be adjusted.

[0023] Water that has been discharged from water outlet 52 has an initial velocity, but because this is very small compared with the flow rate of the nitrogen flowing throughout the pipes, particle-shaped water droplet Wp is subject (as shown in FIG. 2) to (i) downward-acting self-weight *mg* as a result of its mass *m*, and (ii) drag *D*, this being an upward-acting pressure resistance produced by the flow of nitrogen, with drag *D* being larger than self-weight *mg*. As a result, due to the difference between these forces, water droplet Wp is carried in the direction of the nitrogen flow; and due to drag *D* being non-uniform, its surface expands, whereupon the droplet divides into smaller droplets. A decrease in the size of the water droplet means that the transport force becomes even larger than its self-weight, and that the droplet can be transported by a small force. As a result, a balance is established among the self-weight of the water droplet, the transport force, surface tension and so forth, and the water ejected from nozzle 5 is ultimately

divided into small droplets of approximately constant size and is transported through the pipe at an approximately constant flow rate.

[0024] When water droplets that have been divided into smaller droplets in this way reach an injection head 26 of compartment C_1 along with nitrogen, their pressure drops from a high pressure of 110 kgf/cm^{2}G to atmospheric pressure, and they rapidly expand and are sprayed into the compartment. Due to such an extremely large pressure difference, the small droplets of water are further reduced in size by air resistance and become minute droplets. The resulting mist fills [30] the compartment along with the nitrogen. Then, when the high water content nitrogen envelops the hot gases and smoke of the fire, the water content vaporises and occupies an equivalent volume within the space. Together with the nitrogen, the water vapour displaces the air inside that space. By thus establishing an oxygen-lean condition in the compartment, the fire extinguishing effect is enhanced. In addition, the latent heat of vaporisation results in cooling of the surroundings, and hence a cooling-based fire extinguishing effect is also exhibited. In other words, [*the vaporised water content*] assists the nitrogen both quantitatively and qualitatively, and the number of nitrogen containers can be reduced and the fire extinguishing effect can be increased.

[0025] When – as in the prior art – a spray water injection system is provided as separate lines in parallel with a gaseous fire extinguishing system, the water pressure is 50 kgf/cm^{2}G at most, and hence atomisation is inadequate. As opposed to this, as described above, the present invention employs base mixing with nitrogen [31], and therefore the necessary quantity of water is easily atomized due *inter alia* to the following: (i) the water can be divided into small droplets in advance while it is travelling through the piping; (ii) because the high pressure of the nitrogen can be utilised, a high injection pressure of 110 kgf/cm^{2}G can be obtained; consequently (iii) an even greater pressure reduction and injection effect is obtained for the water, which has already been divided into small droplets under this high pressure; and (iv) the nitrogen gas assists the injection.

[0026] Moreover, because it is not necessary to mix an additive such as glycerine or ethylene glycol with the water, as in a conventional water spray system, environmentally-friendly fire extinguishing based solely on nitrogen and water or water vapour is possible. Furthermore, because minute water droplets and water vapour are harmless to human beings, the system is very safe.

[0027] The foregoing description presented an example in which pipe orifice 4 having orifice 41 is provided in the neighbourhood of nitrogen containers 1 of pipework system 2.

However, if nozzle pipe 5 is disposed as shown in FIG. 1(B), it would also be possible to omit orifice 41, since – as described above – pressure P_2' at water outlet 52 becomes lower than surrounding pressure P_2. In this case, the quantity of water [*discharged*] is less than when orifice 41 is provided, but discharge of water is still possible. FIG. 3 depicts other examples of structures for generating a differential pressure between nitrogen outlet 44 and water outlet 52 of nozzle pipe 5.

[0028] In FIG. 3(A), annular member 5a is provided around the outside of the tip of nozzle pipe 5. This enhances the negative pressure effect of the water outlet, thereby enabling aforementioned P_2' to be decreased and the differential pressure relative to nitrogen outlet 44 to be increased, whereby the quantity of water [*discharged*] can be increased. In this case as well, it is possible to omit orifice 41. FIG. 3(B) depicts an example in which the tip of nozzle pipe 5 has been given a spherical shape and a large number of small holes 5b have been made, so that water can be broken up while being discharged. This can enhance the atomisation of the water.

[0029] FIG. 3(C) shows an example in which pipe orifice 4 has been changed to Venturi tube 9. In this case the necessary differential pressure can be generated in the same manner as with an orifice. FIG. 3(D) gives an example in which nitrogen outlet 44, through which nitrogen flows into nitrogen subsidiary supply pipe 8, has been extended to a central position within the pipe, and in which Pitot tube portion 10 has been provided as the differential pressure generating member, this Pitot tube portion 10 opening towards the upstream side of the nitrogen flow. This enables dynamic pressure to be utilised at nitrogen outlet 44, so that pressure P_1 can be further increased. For example, assuming that nitrogen at a pressure of 110 kgf/cm^{2}G flows at a flow rate of 100 m/s, a pressure equivalent to an approximately 5 metre column of water can be generated by this portion alone [32], and increasing P_1 by this amount enables a larger differential pressure to be obtained. It is also feasible to use such a Pitot tube structure in conjunction with pipe orifice 4. In this case, an even larger differential pressure is obtained, and the quantity of water supplied can be further increased.

[0030] Because the system of the present invention has good water atomisation performance, it is possible to use ordinary nitrogen injection heads for injection heads 26, without modification. However, if required, it would also be acceptable to use known atomisation-promoting nozzles as the injection heads. Such nozzles include spiral nozzles which have straight holes in the centre and swirl holes in the peripheral portion, so that the

water atomisation effect is increased by means of swirl flow; and pin-type nozzles provided with a needle-like member at the fluid outlet with an intervening orifice, so that the fluid collides with this and is broken up into smaller particles, thereby enhancing the atomisation effect.

[0031] Although the foregoing descriptions gave examples in which the gaseous fire extinguishing system is a nitrogen fire extinguishing system, the present invention can also be applied to gaseous fire extinguishing systems that use carbon dioxide or other inert gas, or a mixture of nitrogen with these.

Effects of the Invention

[0032] As has been described above, the invention claimed in Claim 1 provides, in the neighbourhood of the fire extinguishant containers of a pipework system, a water supply member having a water inlet and a water outlet for discharging water into the pipework system. The invention is therefore capable of injecting water into a gaseous fire extinguishant in the base portion of the pipework system. The invention claimed in Claim 1 also provides a water container for storing water, this water container being disposed at a low position in the neighbourhood of the water supply member. Because this water container is provided with a pressurizing gas inlet above the water stored in the container, and a water discharge port communicating with the bottom of the water, pressure can be applied above the water, whereby the water can be pushed out from the bottom.

[0033] In addition, a pressurizing gas outlet opens into the aforementioned neighbourhood portion constituting the pipework system for the gaseous fire extinguishant. [33] The pressurizing gas outlet and the pressurizing gas inlet of the water container are connected by a gas pipe. The water inlet of the water supply member and the water discharge port of the water container are connected by a water pipe. This arrangement causes the pressure of the gaseous fire extinguishant flowing through the pipework system to act, and it becomes possible to push out the water in the water container by way of these various ports, this water being pushed out from the water outlet of the water supply member.

[0034] Because the pressurizing gas outlet and the water outlet are provided in a relation such that the pressure of the pressurizing gas outlet becomes higher than the pressure of the water outlet when the gaseous fire extinguishant flows in the pipework system, when a fire has broken out and gaseous fire extinguishant is flowing, a differential pressure is generated between the pressurizing gas outlet and the water outlet, and this differential

pressure pushes out the water in the water container from the water outlet, and water is discharged into the gaseous fire extinguishant.

[0035] Due to the flow of gaseous fire extinguishant in the pipework system, this ejection of water is carried out automatically and, in theory, without fail. Consequently, water can be reliably supplied without any particular operation being required – i.e., without risk of erroneous operation or the like. Moreover, because the water supply member, the water container and the pipe connecting these are provided in the neighbourhood of the pipework system, all of these components can be arranged in the container room in which the gaseous fire extinguishant containers are installed.

[0036] In a conventional system, a large number of long water pipes are laid up to the fire extinguishing target compartments, and the invention claimed in Claim 1 enables these water pipes to be eliminated. As a result, a facility capable of dual-fluid fire extinguishing with water and a gas can be greatly simplified; the space taken up by pipework can be reduced; and cost can be decreased. Moreover, the only change is to add a water supply portion, and there is no need to alter the gaseous fire extinguishing system itself. In addition, because the added portion has a simple structure, the invention is readily applicable to an existing gaseous fire extinguishing facility.

[0037] Furthermore, because water is mixed at the base [*of the fire extinguishing lines*], the long pipework system extending to the fire extinguishing target compartments can be utilized so that injected water is divided into small droplets on the basis of the action of the high-speed flow of gaseous fire extinguishant. Also, when gaseous fire extinguishant containing water droplets that have been made smaller in this way is injected in a fire extinguishing target compartment, the water can be atomized extremely efficiently due *inter alia* to the following: (i) the water droplets have already been made into smaller droplets in the pipework system; (ii) the high pressure of the gaseous fire extinguishant can be utilised for very high pressure injection; (iii) the gaseous fire extinguishant assists the injection.

[0038] When the gaseous fire extinguishant containing a large amount of atomized water is emitted and fills the fire extinguishing target compartment and envelops the hot gases and smoke of the fire, the water content vaporizes and occupies an equivalent volume within the space. It thus supplements the gaseous fire extinguishant, establishes an oxygen-lean condition in the compartment, and thereby enhances the fire extinguishing

effect. In addition, the latent heat of vaporization of the water cools the surroundings, and a fire-suppressing effect is also exhibited.

[0039] In other words, the water assists the gaseous fire extinguishant both quantitatively and qualitatively, and can decrease the consumption of gaseous fire extinguishant and increase its fire extinguishing effect. Such effects become even more pronounced due to the gaseous fire extinguishant accompanying the atomized water, and due to it being discharged in the same direction from the same location at the same time. Moreover, because it is not necessary to mix an additive with the water, environmentally-friendly fire extinguishing can be performed. Furthermore, because minute water droplets and water vapour are non-toxic, there is a high degree of safety during fire extinguishing.

[0040] The invention claimed in Claim 2 comprises, in addition to the above-described [*components*], a differential pressure generating member serving as the neighbourhood portion. [34] The invention claimed in Claim 2 also provides the pressurizing gas outlet in a relatively high-pressure portion, and provides the water outlet in the vicinity of a relatively low-pressure portion. A larger differential pressure can therefore be reliably generated and the supply of water from the water supply member is easy and reliable, whereby a larger quantity of water can be supplied. As a result, the amount of gaseous fire extinguishant can be further decreased, and various other benefits – including the fire extinguishing effect, improved safety, and the reduction in the cost of fire extinguishing – can be further enhanced.

Brief Description of the Drawings

FIG. 1 gives an example of a gaseous fire extinguishing system equipped with water spray, to which the present invention has been applied. FIG. 1(A) is explanatory of the overall system, and FIG. 1(B) is explanatory of its water injection portion.

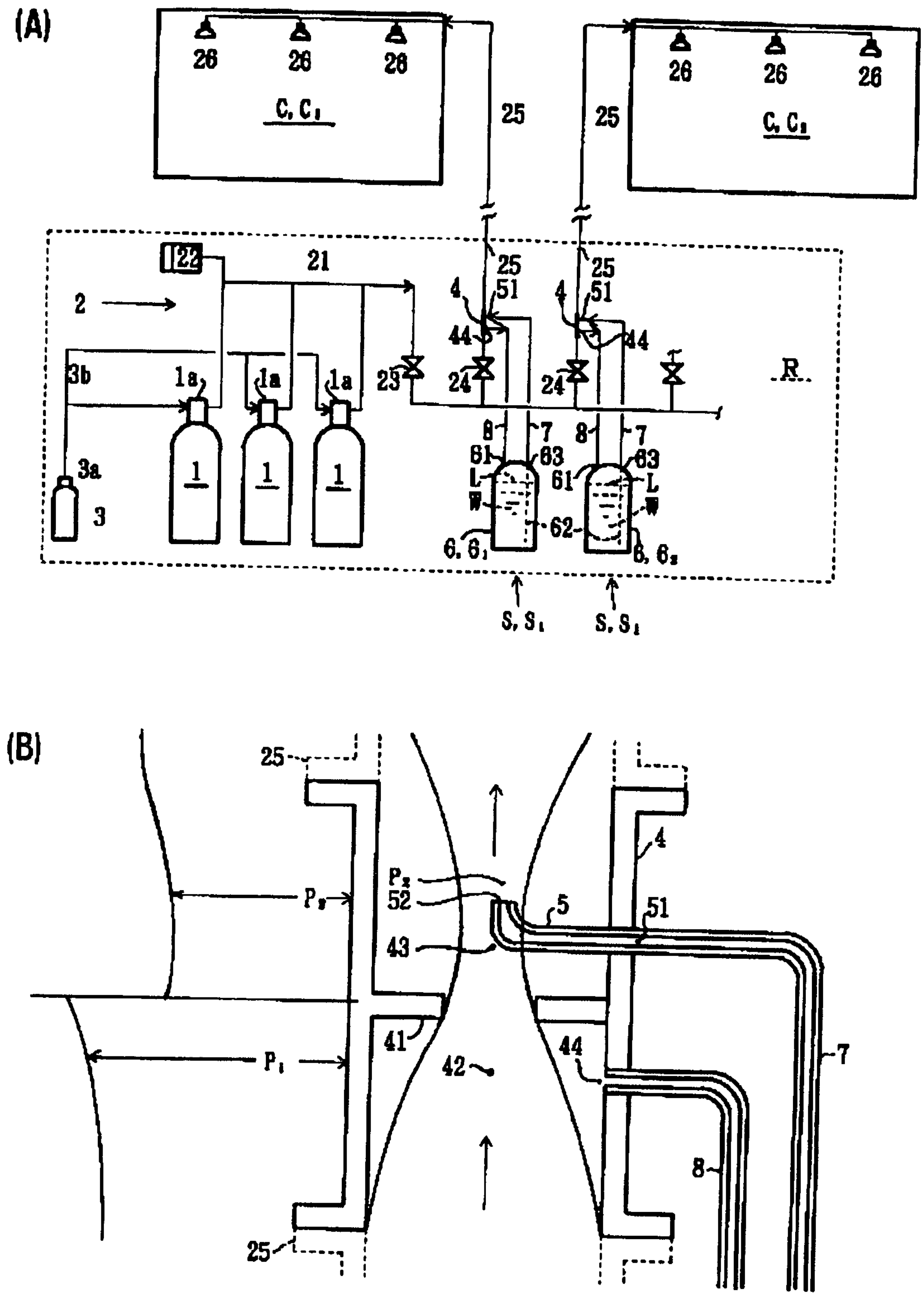
FIG. 2 is explanatory of the state of flow of a water droplet in a high-speed nitrogen stream.

FIG. 3 is explanatory of other examples of structures for the differential pressure generating portion, with (A) depicting the provision of an annular member at the tip of the nozzle pipe, (B) depicting a nozzle pipe tip formed as a perforated spherical part, (C) illustrating the use of a Venturi tube, and (D) illustrating the use of a Pitot tube for the nitrogen outlet.

Explanation of referencing symbols

1 .... nitrogen container (fire extinguishant container)
2 .... pipework system
4 .... pipe orifice (differential pressure generating member, neighbourhood portion)
5 .... nozzle pipe (water supply member)
6 .... water container
7 .... water supply pipe (water pipe)
8 .... nitrogen subsidiary supply pipe (gas pipe)
9 .... Venturi tube (differential pressure generating member, neighbourhood portion)
10 .... Pitot tube portion (differential pressure generating member, neighbourhood portion)
41 .... orifice (differential pressure generating member)
42 .... upstream portion (relatively high-pressure portion)
43 .... downstream portion (relatively low-pressure portion)
44 .... nitrogen outlet (pressurizing gas outlet)
51 .... water inlet
52 .... water supply port
61 .... nitrogen inlet (pressurizing gas inlet)
63 .... water discharge port
C .... fire extinguishing compartment (compartment, fire extinguishing target compartment) [35]

FIG. 1


(A)
26
26
26
C, C1
25
25
26
26
26
C, C2
22
21
2
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4
51
44
25
4
51
44
3b
1a
1a
1a
23
24
24
R
8
7
8
7
3a
61
63
63
L
61
L
W
W
3
1
1
1
62
62
6, 61
6, 62
S, S1
S, S1
(B)
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P2
P2
52
5
51
4
43
41
44
P1
42
7
8
25

FIG. 2

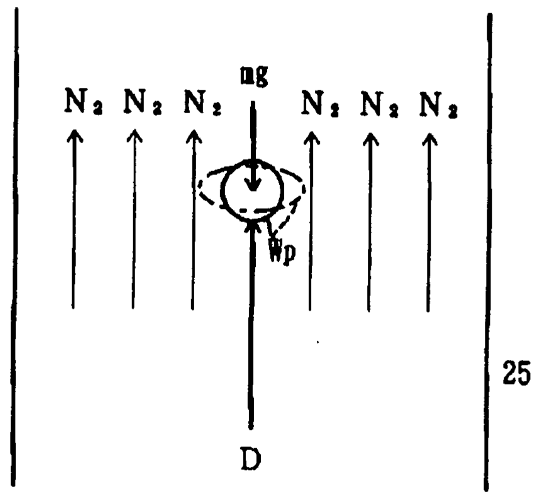
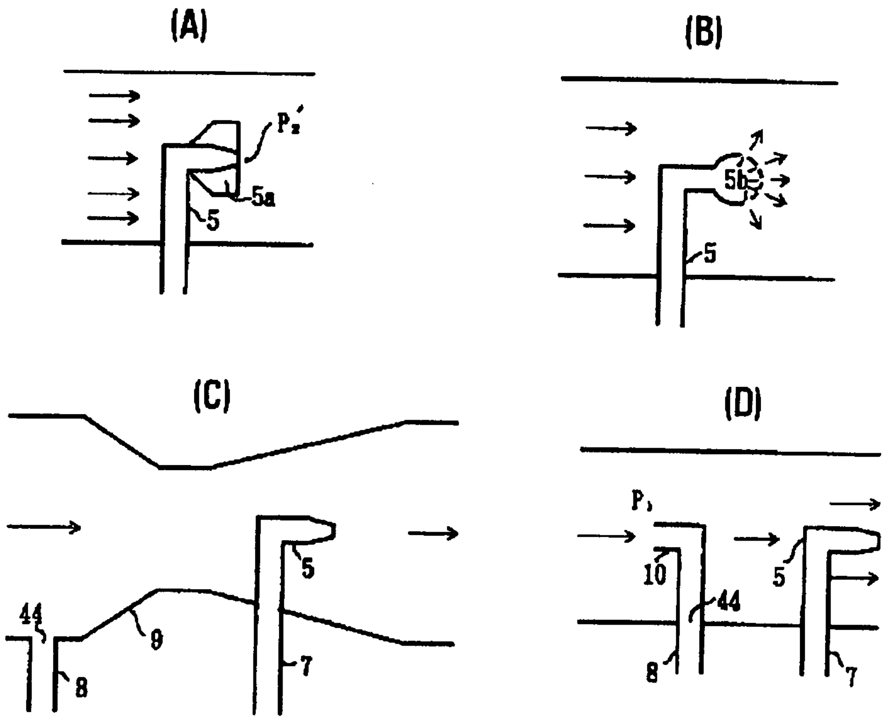


FIG. 3



TRANSLATOR'S NOTES

1. Water outlet 52 is also called the "water supply port".
2. The Japanese which I have translated as "is turned into small droplets" is literally "is made into small particles".
3. I have added the italicised words in square brackets to clarify the meaning of the Japanese sentence, which omits any corresponding words. This same remark applies to other instances of italicised words in square brackets.
4. Sic. It turns out that by "without changing an existing nitrogen-based fire extinguishing system", the writer means something along the lines of "without changing an existing nitrogen-based fire extinguishing system, apart from the addition of a spray water injection portion".
5. This system of pipework is referenced 2 in FIG. 1(A).
6. This water supply member is identical to "nozzle pipe 5" mentioned in the abstract and shown in FIG. 1(B).
7. In some embodiments, this "neighbourhood" is equivalent to "pipe orifice 4". It is also equivalent to the "differential pressure generating member" mentioned in Claim 2.
8. This "water inlet" is referenced 51 in FIG. 1.
9. This "water outlet" seems to be identical to "water supply port 52" shown in FIG. 1(B).
10. The explanation of referencing numerals preceding the drawings indicates that this "pressurizing gas inlet" is identical to the "nitrogen inlet" referenced 61 in FIG. 1(A).
11. This "water discharge port" is referenced 63.
12. This "pressurizing gas outlet" is equivalent to "nitrogen outlet 44" mentioned in the abstract and shown in FIG. 1(A) and (B).
13. This "water pipe" is identical to "water supply pipe 7" mentioned in the abstract and shown in FIG. 1(A) and (B).
14. This "gas pipe" is identical to "nitrogen subsidiary supply pipe 8" mentioned in the explanation of the referencing numerals and shown in FIG. 1(A) and (B). Note that in the abstract, it is referred to as "nitrogen introduction pipe 8".
15. According to the explanation of the referencing numerals, specific examples of this differential pressure generating member are orifice pipe 4, Venturi tube 9, Pitot tube 10, and orifice 41.
16. The Japanese term which I have here translated as "spray" can also be rendered as "mist".
17. The term "automatic" applied to the additional water mist system which characterizes this invention is my free translation of the Japanese, which literally reads "... a highly effective and very safe gaseous fire extinguishing system which additionally has a clean water mist system which is inexpensive, simple in structure, and which does not require manipulation/control/operation."
18. In the Japanese text, the following description of the invention is an exact reproduction of Claim 1.
19. The Japanese text corresponding to the two bulleted sub-paragraphs is an exact reproduction of the corresponding text in Claim 2.

20. By "spray water injection portion", the writer means that portion of the system where water is injected for subsequent conversion to water spray or mist. This portion appears to be the inventive step.

21. See FIG. 1(B).

22. The writer is trying to indicate that nozzle pipe 5 is an example of the water supply member mentioned in Claim 1.

23. The writer is trying to indicate that water supply pipe 7 is an example of the water pipe mentioned in Claim 1.

24. The writer is trying to indicate that nitrogen subsidiary supply pipe 8 is an example of the gas pipe mentioned in Claim 1.

25. Usually termed "pipe orifice 4".

26. Sic.

27. Erroneous for "starter 3a".

28. Hitherto, this has been termed "nozzle pipe 5".

29. This is my slightly free translation of the Japanese, which is literally "... water can be supplied without performing an operation of any sort".

30. The Japanese word which I have translated here as "fills" could also be translated as "floods/saturates/permeates".

31. By "base mixing", the writer means that the spray water is mixed with the nitrogen gas not in the extinguishing compartment but at the beginning of the extinguishing lines.

32. By "this portion", the writer presumably means Pitot tube portion 10.

33. Sic. This is an odd-sounding statement. However, I have double-checked the translation and confirmed that it is faithful to the Japanese.

34. Sic. This is a reference to the fact that certain portions of the system of the invention are disposed in the neighbourhood of the extinguishant containers.

35. I have translated this list as it appears in the Japanese text. It is not exhaustive.